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# Guest Editors' Introduction, Advancing Europe's Fortunes

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GUEST EDITORS' INTRODUCTION

# ADVANCING EUROPE'S FORTUNES

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hen the Commission of the European Communities launched its first technology-development initiative a decade ago, its goal was to strengthen the ability of European technology companies to compete in world markets. The CEC assumed that no single information-technology company could succeed on its own, given the rising costs and risks of investment and the increasing globalization of the market.

The political and economic events that have occurred in the ensuing decade have certainly borne out the vision of a global market dominated by information technology, of which software is a growing segment.

In this issue, some of the people involved describe some results and lessons learned from projects undertaken in the two largest CEC initiatives: the European Strategic Program for Research in Information Technology and Research and Development in Advanced Communications in Europe.

ESPRIT, summarized in the box on pp. 16-17, is a broad-based technology initiative, but information technology is its largest component. Since ESPRIT's launch in 1984, the CEC has funded it with 3.9 billion ECUs (about \$4.8 billion according to an exchange rate of 1.24; all ECU figures converted to dollars in this issue use the same

◆ *Europe has spent billions in public and private funds on developing its information-technology industry. This effort has certainly made the EC a stronger global competitor; but the question remains: Is it strong enough?*



### ESPRIT III: TRANSFERRING BEST PRACTICES

ESPRIT, a 10-year project initiated by the CEC in 1984, is part of an overall research-and-development effort designed to create a critical mass of expertise so that a unified EC can compete in the global marketplace. ESPRIT seeks to

- ◆ encourage cooperation among potential competitors and between industry and academia;
- ◆ improve technology; and
- ◆ progress toward standards.

The first phase was oriented toward technology, not commercialization. The second phase emphasized the development of technology that was not simply better, but more useful to business. Three features and two project summaries in this issue report on results achieved in this phase. ESPRIT, which has six domains, has involved more than 10,000 people and 1,500 organizations.

**Market-driven.** It is now very

difficult to divide the work done under the ESPRIT umbrella into "phases." Yet it is clear that a new part of the project has begun, one being driven by the needs of industry: Exploiting technology in the market is the paramount goal. In fact, although the CEC administers and controls the program, its industry partners help set the objectives, through regular consultations with the CEC and research partners.

The ESPRIT domain of most interest to the software community is the information-processing system and software area. However, other domains — especially advanced business and home systems and computer-integrated manufacturing — have produced results that are also significant to software.

IPSS focuses on improving software quality, productivity, processes, and tools. In each area, it aims to provide a range

of generic technologies that its industrial partners can customize. There are 50 current projects, divided among four areas, as Figure A shows.

◆ *Information-processing systems and software.* These projects will bring together the previous work on systems design and knowledge-based systems, embracing both hardware and software. The four subareas are process, tools and environments, knowledge-based system components, and support for complex applications (such as real-time systems).

◆ *Advanced computer systems architecture.* The projects in this area focus on improving the usability and programmability of massively parallel architectures

and on providing some necessary critical components. In addition to development of new microprocessors, transputers,

models and tools for programming database systems, and Fortran, projects in this area are exploring new computing paradigms such as optical and neural networks.

## ESPRIT NOW HAS AS ITS PRIMARY GOAL THE EXPLOITATION OF RESULTS BY INDUSTRY.

◆ *Information servers and interface.* This component targets the servers in client-server systems, in that it focuses on technologies for information management and presentation. Projects in this area draw on work done in parallel processing, knowledge representation, database management, and user interfaces. Among the issues being addressed are information man-

exchange rate). Its industrial partners have contributed that much more.

RACE, which is more narrowly focused on telecommunications technology, is summarized in the box on pp. 18-19. Since RACE's launch in 1987, the CEC has contributed 1 billion ECUs (about \$1.24 billion), and its industrial partners that much more.

### RETURN ON INVESTMENT

What has been the return on this enormous investment? Compared with the situation a decade ago, the information-technology industry's influence on the development of our industrial, economic, and social fabric has grown enormously. But it is also clear that the industry's growth is now far slower than it has been in the last 20-plus years.

Yet, as the authors in this issue state, the CEC-sponsored initiatives are now more sharply focused on meeting market needs, not just generating new research results. Project quality is up, which has improved

the motivation of industrial partners. The CEC admits that some projects were terminated when it became clear they would not reach their objectives, but fewer than 10 percent of ESPRIT projects are considered to be complete failures.

Perhaps the best-known success is the Portable Common Tool Environment. PCTE-based environments are now commercially available on platforms sold by many vendors; PCTE is a European standard<sup>1</sup> and is under consideration by the International Standards Organization.

However, industrial participants have not always been satisfied with the return on their investment. Obviously, it is difficult to coordinate goals, methods, and tools across companies and countries, especially when the objectives must be perceived as mostly long-term. The dearth of quantitative results reported here is indicative of the overall problem the global software community faces when it tries to transfer research into industry.

Despite these frustrations, successes like PCTE show that it is possible to trans-

fer technology from country to country and domain to domain, as well as from research centers to industry.

### EUROPEAN SOFTWARE INSTITUTE

Indeed, the CEC has demonstrated its satisfaction in these coordinated projects by launching the European Software and System Initiative earlier this year. ESSI is a technology-transfer initiative that will, in its initial 18-month phase, involve about 80 to 100 projects.

Also this year, leaders in the European information-technology market founded the European Software Institute to serve both vendors and users. ESI is to

- ◆ select and apply a software-process evaluation and improvement framework;
- ◆ help members evaluate their current practice, and
- ◆ use these results to assist with improvement programs.

For more information about this and other EC initiatives, see the box on p. 20.

agement in different representation paradigms, management of cartographic and general image data, efficient and distributed storage, CD-ROMs, and natural language for information retrieval.

♦ *Signal-processing systems.*

Work in this area concentrates on applying machine understanding of image and speech signals. Image-processing projects are prototyping automatic visual inspection systems for quality control and surveillance systems for safety-critical applications. Speech-processing projects address automatic information access through the telephone, voice-activated dialing, and dictation machines.

**Dissemination and exploitation of results.** ESPRIT has succeeded in its role as a catalyst for collaboration among large, medium, and small companies and academic institutions. Transferring

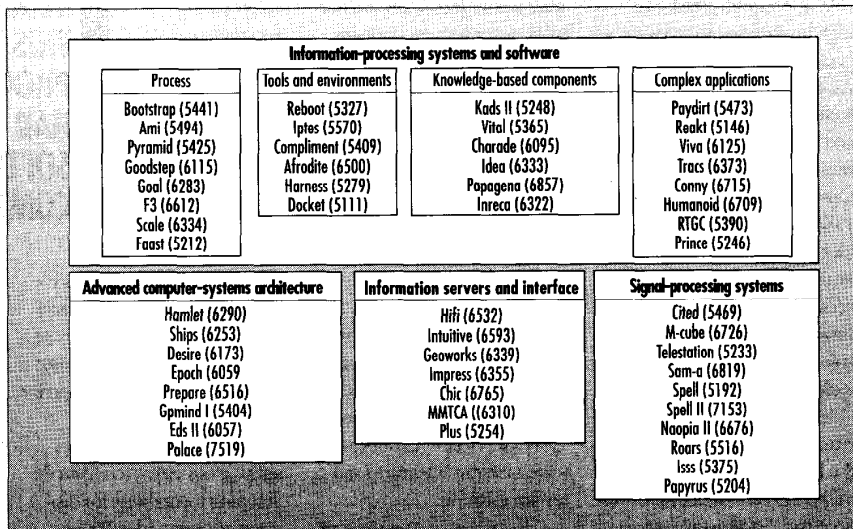
research results into actual use is the chief concern of ESPRIT participants and everyone associated with the European information-technology industry.

The CEC has made special efforts to support technology

dissemination through events and services such as conferences and exhibitions, workshops, seminars, and special-interest groups. In addition, many projects have as a specific objective the exploitation and

publication of their results, such as the software-metrics and quality-standards projects. The box on p. 20 describes how to get more information about all CEC software initiatives.

—*Arnie Kuntzmann-Cambelles*



**Figure A.** The four main areas that make up the last phase of ESPRIT; all projects whose number begins with a five or six began between 1989 and 1992. The selection of the final projects, initiated in May 1993, is not yet complete.

## IN THIS ISSUE

Most of the articles in this issue report on methods and tools to improve the development process. Obviously, this selection does not cover the full range of topics addressed by the ESPRIT and RACE initiatives; we selected the most interesting submissions, but admit to being frustrated by the lack of participation on the part of the better known projects.

The first four articles distill more general lessons learned in doing project work.

♦ In the first article, Christophe Debou, Norbert Fuchs, and Heinz Saria describe their efforts to introduce technology with a complete plan for its implementation and acceptance. Their framework, which draws from several ESPRIT and RACE projects, centers on the formation and testing of hypotheses about technology. They describe two applications: introducing complexity metrics and formal-description languages to developers at Alcatel.

♦ In the second article, James Callaghan

and Terry Turner describe a unique project funded by the RACE program. The principal objective of the Guideline project was to coordinate work done on other RACE technology projects. In serving as a coordinator, Guideline has made an important contribution to the development of a common, open telecommunications computing platform.

♦ The third article, by Nigel Shadbolt, Enrico Motta, and Alain Rouge, describes an ESPRIT project that also tries to exploit the work done in many projects. The goal of the Vital project is to define a complete, structured life cycle for knowledge-based systems and some integrated tools.

♦ In the fourth article, Petri Pulli and Marko Heikkinen describe the application of two mechanisms to concurrently engineer real-time systems: prototyping with graphical animation and a change-management mechanism, called redoing. The authors describe work underway on a change mechanism that records and plays back design history, potentially reducing the penalty for changes made late in devel-

opment.

To offer more diversity, some reports are written as short project summaries. Three summaries describe ESPRIT projects:

♦ Milena Didic describes a project from the computer-integrated-manufacturing domain. The Voice I project developed McCIM, the first on-line implementation of an open-systems architecture for designers of CIM systems. McCIM closes the gap between work on CIM models and an infrastructure for integrating operations within an organization. CIM system developers use McCIM to rapidly prototype authentic manufacturing systems.

♦ Umberto Cavallaro and colleagues describe the HIFI project, which is building interactive navigational tools for information systems. HDM+, a model for the navigational interface and an extension of the well-known Hypertext Design Model, maps a high-level description of a desired type of navigation to a high-level description of the databases. This project is only

## RACE II: EVOLVING SERVICE ENGINEERING

The ambitious goal of the CEC's Research and Development in Advanced Communications in Europe program is to aid the introduction of integrated broadband communications throughout the EC.

From the beginning, the RACE program attached a high importance to software, as evidenced in the work on advanced information-processing techniques, software methods and infrastructures, and, more recently, service engineering. During its definition phase in 1986, the program's partners identified the need to adopt an unbundled approach for the production of software, which should be developed with reusable components and formal techniques as much as possible.

All together, software-related RACE projects during the last seven years devoted 230 million ECUs (about \$285 million) and 2,000 man-years to the research and development of telecommunications software.

**Phase I: Goal-setting.** The feature article and project summaries in this issue cover some of the work done in the first phase of RACE, which began in 1988 and ended in 1992. RACE I involved 93 projects and 300 organizations from 17 countries. Its goal was not to produce marketable products, but to pave the way for the development of such products by specifying, through detailed prototypes and practical trials, the methods and tools that would

be needed.

Work in RACE has tackled this complex problem by following an evolutionary approach.

First, we worked to provide a programming infrastructure and extensively applied software techniques in several network-management domains. This work helped identify the two areas where results would best be applied: rapid service provision and open telecommunications architectures.

Although every RACE project has its own goals, objectives, and deliverables, the program's real power comes from its coordinated nature. In the RACE program, we have consistently integrated what we know about the user-service relationship and how to manage the provision of services with our research into architectures and service creation.

We recognize that the fundamental concepts underlying information and telecommunications technologies are convergent, not divergent. So we tried to take full advantage of concepts developed in both the information-technology and telecommunications domains.

Recognizing this convergence encourages us to exchange views, establish consensus, and take a long-term view of the problem of how to provide more services more rapidly.

Project Rosa was instrumental in developing concepts for service engineering. The output of Rosa provides a step to-

ward the goal of an open services architecture.

In RACE II, which began in 1992 and will end in 1995, research and development shifted from exploring options to preparing for implementation.

### Phase II: Service engineering.

There are 90 RACE II projects, all designed to establish the feasibility of the technology and applications developed in RACE I. Out of these, 13 focus on *service engineering*. Although the concept of service engineering is still taking shape, in general it involves shifting our approach from developing technology for discrete services to developing technology for the flexible engineering of integrated services.

The objective of RACE II in this area, then, is to develop the harmonized architectures, specifications, methods, and tools necessary to provide a service-engineering environment that can accommodate the rapid, flexible introduction of new services, maintain them throughout their life, and manage them.

Figure A diagrams the five main areas in this Integrated Services project line:

◆ *Personal-service communication space.* Project Mobilise will develop the concept of per-

sonal-service communication space, derived from user needs for personal communication and mobility. It derives require-

ments for management, security, user interfaces, and architectures.

◆ *Open service architecture.* In this area, the Cassiopeia project is defining an open services

architecture and achieving consensus among stakeholders. In this context, "architecture" is more than a system's functional organization — it is a philosophy of how to build telecommunications applications. We intend to support openness in technology (services can be developed or enhanced independently of changes in the infrastructure), of time (services can be introduced at any time), and in space (service location can be transparent). Among the most critical issues to achieving this openness is how to decouple the service from the network.

◆ *Communications management.* The philosophy of the RACE program is that service management should form an integral part of the architecture. The five projects in this area will build on phase I network-management work.

Gema and ICM will focus on network management, attempting to scale up phase I results

## FROM THE BEGINNING, THIS TELECOM PROGRAM HAD A LARGE SOFTWARE COMPONENT.

half completed, yet it has already reported some success in validating its modeling techniques.

◆ Martin Bush and Nicholas Ashley summarize the results of the completed Metkit project. This project developed two training packages on goal-driven measurement, one for industry and one for academia. Metkit also produced a text-

book and a computer-aided instruction system. More than 5,000 students have used these materials.

Four other summaries describe RACE I projects:

◆ The Specs project, summarized by Michel Dauphin, Georges Fonade, and Rick Reed, is a very large effort to develop a methodology for the use of formal con-

cepts to develop telecommunications software.

◆ Patrick McLaughlin highlights some aspects of the Arise project, which strived to identify what CASE environments must have to support network development. Arise focused on supporting software reuse.

◆ A case study undertaken as part of

and integrate the prototype architectures and systems already developed. Prism, Prepare, and Dessert will focus on service management, including the issues of constructing management services, interdomain management (interfaces, protocols, and so on), and the development of a decision-support system.

◆ *Service-creation environments.* Two projects, Score and Boost, will attempt to provide intelligent support to service creators. The goal is an environment that will let developers build services by combining components from both the network and management domains. But maintaining consistency between network and management components is a real challenge: Introducing a new network service must be accompanied by an equivalent management capability. Both Score and Boost hope to raise the level of the user interface to encourage component reuse.

◆ *User-service interaction.* Four projects — Ascot, Lusi, Mits, and Ipsnii — will investigate how to specify components and primitives for end-user applications and address usability design, focusing on the user interface. In addition to addressing how to adapt tools to the skills and requirements of end users, Ipsnii will pay particular attention to people with special needs.

**Future goals.** In summary, RACE Phase II projects hope to

◆ develop and validate an open services architecture composed of logical systems, service models, components, major interfaces, functional elements, and logical reference configurations;

◆ fully characterize what service management entails;

◆ provide object-oriented service-creation environments, built by adapting existing software-engineering tools;

◆ create a framework for developing service components and assembling them into operational telecommunications services;

◆ develop service emulators for experimenting;

◆ supply configuration tools that can be employed by end users;

◆ create metaphors and re-

alize them in new user interfaces; and

◆ develop guidelines on what is technically feasible to serve people with special needs.

Through their serious commitment to collaborative research and development within the RACE program, manufacturers, operators, research centers, and leading-edge users have made a significant contribution to European expertise.

These partners adopted prototyping as the preferred means to validate the correctness and adequacy of technology, participated in international conferences, helped deploy new standards, and sought to establish worldwide consensus.

The multicultural environ-

ment created in the RACE program stimulated creativity and encouraged diversity, which was harmonized through constructive consensus-building. Guiding these projects was the conceptual framework of integrated, broadband communications, which encouraged inter-project interaction, kept the projects focused, and hence contributed to the relevancy of the results.

We have no doubt that RACE will continue to contribute to the state-of-the-art in software and service engineering and provide its partners the means to offer market-driven, cost-effective telecommunications products.

— Spyros Konidaris and Mário Campolargo, *Commission of the European Communities*

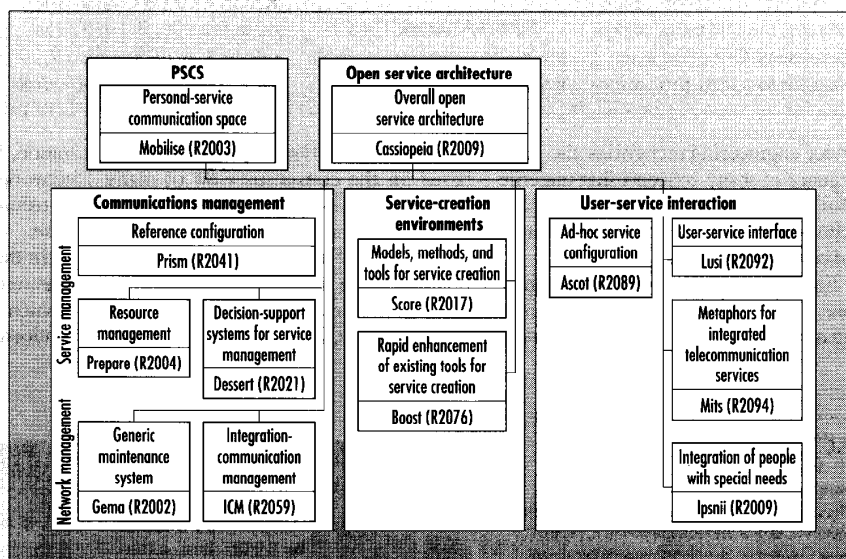


Figure A. The five main areas that make up the service-engineering part of RACE II.

Arise, summarized by Chris Loftus, David R. Pugh, and Edel Sherrat, explored the feasibility of operating a PCTE over a wide-area network. The authors conclude that a wide-area PCTE requires a careful data-distribution strategy.

◆ Terry Turner and Ben Hurley describe work on an architecture for network- and customer-administration sys-

tems. The model-based management architecture the Advance project defined provides clear mappings from the NCAS domain to application- and system-level design entities.

**E**urope's ability to produce innovation and compete in a global market depends on a solid scientific and technologi-

cal foundation. The partners in the existing CEC programs, ESPRIT and RACE in particular, should realize great profit from their efforts, which will stimulate emerging systems and application technology.

RACE has now entered its second phase, in which the concept of service engineering will take form. In essence,

## SIGNPOSTS AND LANDMARKS: A GUIDE TO INFORMATION ON CEC-SPONSORED INITIATIVES

It is often said that there is a shortage of publicly available information on programs sponsored by the Commission of the European Communities. In fact, there is an abundance of technical reports, program summaries, and other types of documents, but many people do not know they exist.

**Initiative information.** Value is a CEC program that promotes the dissemination and exploitation of information and results from all CEC initiatives. In addition to disseminating information, Value II seeks to analyze the effect of applying results in three areas: research to industry, research to research, and research to society.

One unit — the Dissemination of Scientific and Technical Knowledge Unit — has a responsibility to disseminate and promote the application of projects results. One of the main channels to achieve this promo-

tion is Cordis (Community Research and Development Information Service), a set of electronic databases that includes information about programs, projects, publications, results and prototypes, acronyms, news, and partner profiles.

The project database contains about 18,000 projects and is updated monthly. Access to Cordis is free, and it can be searched through a query language or by menu. Cordis is also available on a CD-ROM that is updated quarterly. More than 5,000 organizations subscribe to Cordis. In addition to this general service, the CEC has opened centers in several member states to provide support for transferring the technology developed in its projects.

**ESPRIT information.** The following documents are available from the General Directorate

III, Rue de la Loi 200, B-1049 Brussels:

- ♦ projects synopses, a one- to two-page description of individual projects including objectives, results, and the consortium involved;
- ♦ the annual report, edited by the CEC, reporting results and progress;
- ♦ a significant collection of published books that either describe the results achieved in a specific project (such as *PCTE: The Standard for Open Repository*, Prentice-Hall, 1991) or give a coherent view of the contribution of ESPRIT projects in a specific area (such as *Enhancing the Knowledge-Engineering Process*, North Holland, 1992).

**RACE information.** These documents are available from the RACE Central Office, Rue de la Loi 200, B-1049 Brussels or Ave. de Beaulieu 9, 4/64 B-1160, Brussels; raco@

postman.dg13.cec.be; compuserve 100013.1437:

- ♦ *RACE 93 Technical Report*, March 1993.
- ♦ *RACE I and RACE II Workplans*.
- ♦ *RACE Final Report on Phase I (1988-1992)*.
- ♦ *RACE Common Functional Specifications*, Issue C, R2083, April 1993.

In addition, the RACE office has a good collection of articles and conference papers that are available on request. A good summary of the work performed in network management is *The Management of Telecommunications Networks* (R. Smith et al., eds., Ellis Horwood, 1992). For a summary of the Specs project, see *Specification and Programming Environment for Communication Software — Specs* (R. Reed, ed., Elsevier Science Publishers, 1993).

— Annie Kuntzmann-Combelles and Mário Campolargo

service engineering recognizes the convergence of many concepts that underlie information and telecommunications technologies — it is flexible, integrated, and customer-oriented.

ESPRIT is now approaching completion, and is due to be followed by new initiatives under its fourth framework

program. The initiatives proposed will be based on the consensus view of many hundreds of information-technology vendors, users, and research centers. Some fields of investigation will be enlarged, such as high-performance computing. Advanced domains such as simulation, artificial intelligence, visual-

ization, large-database management, and networking will need new computer architectures — both hardware and software.

In the end, the goal of all these initiatives remains the same: A stronger market position for the EC's technology providers relative to their global competitors. ♦

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